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No. 278

GENERAL RULES FOR METAL AIRCRAFT CONSTRUCTION.

By Alessandro Guidoni. *4.2*

From "Rendiconti Tecnici della Direzione Superiore del Genio
e delle Costruzioni Aeronautiche," March 15, 1924.

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GENERAL RULES FOR METAL AIRCRAFT CONSTRUCTION.*

By Alessandro Guidoni.

The Commissariat of Aviation deems it expedient to issue a few rules of a general character which should be followed by constructors in designing aircraft, into the manufacture of which metal enters to a considerable extent.

Materials.

Aluminum, duralumin, soft steel, high-resistance steel: in sheets, in tubing and shaped elements. For a few very special parts, steel, aluminum, or light alloys may be used.

Principal Structures.

Fuselage: Fuselages of fabric-covered steel tubing must be excluded, that is, fuselages in which the wooden members (longerons, struts) have simply been replaced by steel tubing. For the fuselage, it is preferable to employ sheet-metal which, aside from constituting the external covering, sustains all longitudinal stresses, so that it is only necessary to secure indeformability by means of transverse frames. The longitudinal and transverse riveting of the fuselage covering is therefore of the highest

* From "Rendiconti Tecnici della Direzione Superiore del Genio e delle Costruzioni Aeronautiche," March 15, 1924, pp. 5-8.

importance, because of the stresses which the covering has to undergo.

Tail Surfaces - Rudders: For the tail surfaces, the type with internal framework is preferred. If the tail surface is metal, it must withstand the principal stresses, while the function of the framework is to secure the indeformability of the sections. For both the horizontal and the vertical fin, metal covering, at least partial, is preferred, but fabric covering is also admissible. For the rudder and elevator, fabric covering is preferred.

Wings: It is necessary to make a distinction between the normal types of wings and those which are of such thickness as to permit the number of struts to be reduced to one single couple on each side, as well as those with an internal framework employed for monoplanes and bimonoplanes.

In the first type, in which the wing thickness is not greater than that normally employed, steel for the construction of spars, and duralumin for the ribs, appear to give excellent results. Both for the spars and ribs, it is advisable to avoid riveting by stamping them in one single piece from metal sheets suitably lightened by means of flanged holes.

For wings of medium thickness, trellised spars and ribs may be employed. For the spars, it appears that steel may be employed to advantage, while for the ribs, duralumin is more suitable. The wing covering may be entirely of fabric, or of thin

sheet-metal for the upper front part and fabric for the remaining parts. If sheet-metal is employed, it must naturally be considered as a resisting element. Consequently, the sheets must be riveted together and to the internal wing framework so as to resist the stresses to which they are subjected.

Wings with only internal framework may employ either of three different methods:

1. If the covering is entirely metal, the longitudinal internal framework (spars) will be reduced in consequence; this method, even taking into account the lightening of the longitudinal framing, should perhaps be avoided, because it is almost sure to be heavier than either of the two following systems.

2. If the metal covering is limited to the part of the wing of greater thickness, that is, the part of the wing close to the fuselage, the internal framework must differ in the two wing portions, metal and fabric-covered, bearing in mind, however, that, in the metal-covered part of the wing, the covering assists in withstanding the stresses.

3. Lastly, the wing may be entirely fabric-covered. In this case it is quite logical to employ two or more trellised metal spars of steel or aluminum, or else the usual trellised framework of duralumin.

The spars, and possibly also the trellised framework, may be made of both wood and metal by employing wood particularly for the flanges and metal for the webs of the spars and ribs. This

may be advantageous for the fabric covering, because in this case, the fabric is simply nailed to the wooden flanges of the ribs.

Attachment of the Wings to the Fuselage: Though on the one hand, it might be desirable for saving weight, to build the wing in one piece, it is necessary, on the other hand, for considerations of transportation, to provide for the disassembling of the airplane, even if of small dimensions, into its essential parts: cell and fuselage. For the various cases (biplane, "bimonoplane" and monoplane) the methods evidently must be different. For biplanes, it is well to avoid transverse and longitudinal wing bracings; for "bimonoplanes," the upper and lower wings possibly should each be in one single piece, while in monoplanes, the fuselage could be incorporated with the thicker parts of the wings, so that only the wing extremities, which are much lighter on account of the fabric covering, as explained above, could be removed.

Floats: Naval experience has taught that wood is more suitable for small floats because possessing local resistance which is lacking in sheet-metal of minimum thickness. Two-ply or three-ply wood, with layers glued crosswise and fabric interposed between the layers, is still best for floats and especially for the bottom. As regards the dependability of the float, from the viewpoint of static support in the water, the advantage of a metal hull is self-evident.

In seaplanes with central fuselage, the latter may constitute the required floating reserve in an emergency, while the float

itself has only taking-off and alighting functions. Should the float be accidentally destroyed, the seaplane can still be floated by the fuselage and the part of the wing furnished with metal covering. In view of the above considerations, it would be advantageous for the float to have a combined wood and metal structure, wood for the bottom, and metal for the rest of the surface and for the internal structure.

The attachments of the floats to the fuselage in a metal airplane must conform to the general outline of the metal structure and must consist of streamlined struts with good fairing at the point of attachment with the other structures.

Landing Gear: The most recent metal seaplanes already afford an idea of the form which, logically, the landing gear must assume, according to the principles set forth above for the attachments of floats. It would appear that the reduction of the wheel supports to two simple struts of suitable strength will not imply an excess in weight with respect to the normal type of landing gear, especially when taking into account the decreased resistance in the air.

General Remarks.

Designers, in employing metal, must be able to attain for aircraft just as refined details of form, as normally obtain in ship-hull designing. Tank experimentation and actual experience have demonstrated the importance of the shape of a ship's hull (that is, the coefficient of fineness of the main section, of the plan at the

water-line and of the hull) and also of the form and application of the so-called "hull appendixes" with respect to the coefficient of drag.

If the resistance of a bare hull be 1, by adding the propeller brackets and the projecting bearings for the propeller shaft, the resistance will be doubled.

It is absolutely useless to develop a good shape of fuselage if its external shape is altered in installing the engine and providing for the accommodation of the pilot and observer and, above all, in installing the radiator. The alteration is apparently of no importance, but actually exerts a great influence on the total drag.

For instance, the rounding off of the corners and edges of the fuselage may result in a reduction of 5% in its resistance. Such details, however, are well known to our constructors and consequently, it is not necessary to dwell on the matter.

If, in 1923, flying was possible with a 4 HP airplane, while in 1910 a 25 HP engine was necessary, this was due primarily to the progress made in aeronautical designing.

It is not possible at present to predict great development in metal constructions for technical and economical considerations, but it is the intention of the Commissariat of Aviation to encourage Italian constructors along these lines, limiting their efforts for the present, however, to such special types of aircraft as will be determined later.

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